REMARKS

A. Status of the Claims

Claims 1 and 2 are pending in the application. Claim 1 was rejected under 35 USC 103(a) as being unpatentable over Zhang, US Patent No. 5,835,396 (hereinafter Zhang '396) in view of Zhang et al., US Patent No. 6,111,302 (hereinafter Zhang '302). Claims 1 and 2 were rejected under 35 USC 103(a) as being unpatentable over Zhang '396 in view of Mohsen et al., US Patent No. 4,881,114.

B. 35 USC 103(a) Rejection: Zhang '396 and Zhang '302; Claim 1

Claim 1 was rejected under 35 USC 103(a) as being unpatentable over Zhang '396 in view of Zhang '302.

Claim 1 recites a three dimensional multi-level memory array disposed above a substrate, the array comprising: a first plurality of spaced-apart rail-stacks disposed at a first height in a first direction above the substrate; a second plurality of spaced-apart rail-stacks disposed above the first height and in a second direction different from the first direction; and a plurality of memory cells, each memory cell comprising a silicon nitride antifuse, wherein the antifuses are disposed at the intersections of the first rail-stacks and the second rail-stacks.

The Examiner finds all of the elements of claim 1 in Zhang '396 except the claimed silicon nitride antifuse. The antifuses disclosed in Zhang '302 appear to be, for example, amorphous silicon or protective ceramic (col. 9, lines 26-27). The Examiner suggests replacing the antifuse of Zhang '396 with a silicon nitride antifuse as disclosed in Zhang '302.

The Examiner says:

> A person skilled in the art would further appreciate that since both Zhang '302 and Zhang '396 are directed toward metal-to-metal antifuses using generally similar materials with similar programming voltages ...

Applicants believe, however, that the Zhang '396 and Zhang '302 in fact do not show similar materials, programming voltages, or environments, and thus that no such substitution of antifuse material is obvious.

Fig. 1 of Zhang '302 teaches an antifuse layer 20 which may be silicon nitride between a bottom electrode 14 and a top electrode 22. Both bottom electrode 14 and top electrode 22 are about 4000 angstroms of fairly low-resistivity metals like Ti (col. 5, lines 61-62 and col. 6, lines 56-57). Thin optional barrier layers 16 and 21 of, for example 100 angstroms of W (col. 5, line 64) may intervene. Programming voltage is taught to be between about 3 and about 20 volts (col. 6, lines 40-43.)

In Zhang '369, in contrast, the antifuse layer 502ca of Fig. 10a is between a conductor 501, which may be a low-resistivity metal (col. 5, lines 14-21) and a middle buffer layer 502cc, which may be about 1000 angstroms (100 nm) of W (col. 9, lines 56-58.) The middle buffer layer is adjacent to a quasi-conduction layer 502cb. The actual composition of quasi-conduction layer 502cb is unclear, but in the nearest embodiments the options appear to be amorphous silicon or protective ceramics, or alternatively an amorphous silicon p-n diode (see col. 9 lines 23-26 and col. 9, lines 42-45; and col.6, lines 17-63.)

The antifuses of Zhang '302 and of Zhang '396, then, are in distinctly different environments. The Zhang '302 antifuse is interposed between two low-resistivity metals, whereas the Zhang '396 antifuse is interposed between a low-resistivity metal on one side and a higher-resistivity material on the other side.

The Examiner finds that the two antifuses are designed to operate at similar voltages, but Applicants must disagree. The passage cited by the Examiner in Zhang '302 at col. 6. lines 40-43, names programming voltages in the range of 3-20 volts. The programming voltage is the voltage required to convert the antifuse material from the initial high-resistivity state to the programmed, low-resistivity state. The cited passage in Zhang '396, however (col. 8, lines 60-67), apparently is not referring to the programming voltage of an antifuse, but instead to the IV characteristic of the quasi-conduction layer. Current through quasi-conduction materials at 4 and 12 volts are named, but from the context, which is discussing read operations, it is believed these example voltages are *read* voltages, not programming voltages. No programming voltages are suggested in Zhang '396; in general programming voltages are significantly higher than read voltages. If programming and read voltages are in the same range, there is a high risk that a read operation may inadvertently program a memory cell. Naming of a read voltage in the range of 4 to 12 volts, then virtually guarantees that programming voltage is *not* in this range.

Applicants have shown that the antifuses of Zhang '396 and Zhang '302 operate in very different environments, between unlike materials and in different voltage regimes, and thus that one skilled in the art would not be motivated to replace the antifuse of Zhang '396 with the silicon nitride antifuse of Zhang '302. Applicants respectfully request withdrawal of the 35 USC 103(a) rejection of claim 1.

<u>C. 35 USC 103(a) Rejection: Zhang '396 and Mohsen et al.; Claims 1 and 2</u>

Claims 1 and 2 were rejected under 35 USC 103(a) as being unpatentable over Zhang '396 in view of Mohsen et al.

The Examiner finds all of the elements of claim 1 in Zhang '396 except the claimed silicon nitride antifuse. The Examiner suggests that one skilled in the art would find it obvious to replace the antifuse of Zhang '396 with a silicon nitride antifuse as disclosed in Mohsen et al., again finding the environments in which the antifuses operate to be similar.

The Examiner maintains that Mohsen et al. show "that silicon nitride is an appropriate antifuse for use between metal electrodes or metal and semiconductor electrodes ..." For this teaching the Examiner relies on the following passage in Mohsen et al.:

> Both of the semiconductor materials used to form electrodes 12 and 16 may be made up of a high electromigration immunity material. They may be formed from heavily doped polysilicon, or heavily doped single crystal silicon or a metal or a sandwich of metal and heavily doped polysilicon in the alternative embodiment.

Applicants cannot be certain how to read this passage. The Examiner has apparently interpreted it to mean that either layer 12 or 16 (which are separated by antifuse layer 14) can be any of the named materials: doped polysilicon, doped single-crystal silicon, or metal. In light of all of the other teachings provided by this patent, however, Applicants respectfully suggest that this interpretation does not seem reasonable.

In every description of the invention and described embodiments, including in the abstract, the claims, the summary, Figs. 1-3 and 9a-10b, and at every other point in the detailed description, it is made clear that rupture of the antifuse layer forms a diode; that is, that the antifuse initially separates layers that will form a diode when they are brought in contact upon rupture of the antifuse. In most embodiments, then, the antifuse separates an n-doped semiconductor layer from a p-doped semiconductor layer, forming a p-n

semiconductor diode on rupture of the antifuse. The only exception Applicants can identify is described in column 3, line 65-68, where the antifuse separates an n-doped semiconductor layer from a conductor, forming a Schottky diode on rupture of the antifuse.

Applicants believe the cited passage must be read in this context; that either layer 12 or 16 may be polysilicon, single crystal silicon, or metal, *so long as* a diode is formed upon rupture of the antifuse 14, as is clearly and repeatedly described throughout the rest of the patent.

Applicants find no embodiment in Zhang '396 in which a diode is formed upon rupture of the antifuse layer. The quasi-conduction layer of Zhang '396 is shown *adjacent* to the antifuse layer, as in Figs. 5a, 5b, 10a, and 10b, and elsewhere, but is never shown with the antifuse layer disposed *between* portions of a diode (layers 502ba and 502bb of Fig. 5c, for example.)

Due to the dissimilarity of these devices, Applicants can identify no motivation that would cause one skilled in the art to replace the antifuse of Zhang '396 with the silicon nitride antifuse of Mohsen et al. Applicants respectfully request withdrawal of the 35 USC 103(a) rejection of claims 1 and 2.

CONCLUSION

In light of this response, Applicants believe this application to be in condition for allowance.

If there are any questions concerning this response, the Examiner is invited to contact the undersigned agent at (408) 869-2921.

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Respectfully submitted,

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